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Study of Exhaust Emissions from Forty High Mileage 1981 Passenger Cars

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Apr 84

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16. ABSTRACT

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The test vehicles were drawn from the general public in the Columbus, Ohio area using direct mail solicitation. Only vehicles with over 60,000 miles were sought. This resulted in an average odometer reading for the fleet of 71,410. The tests performed included the Federal Test Procedure, the Highway Fuel Economy Test and several short tests. The program began in July, 1983 and was completed in November, 1983.

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A Study of Exhaust Emissions from Forty High Mileage 1981 Passenger Cars

by

John C. Shelton

April 1984

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Sources
U.S. Environmental Protection Agency

ABSTRACT

This paper describes the results of an exhaust emission testing program conducted on forty 1981 passenger cars. The primary purpose of this program was to examine the emission performance of high-mileage vehicles. Secondary objectives included an assessment of the condition and performance of the emission-related components and the collection of information for development and improvement of I/M programs. The work was performed by Automotive Testing Laboratories (ATL) at the Transportation Research Center in East Liberty, Ohio.

The test vehicles were drawn from the general public in the Columbus, Ohio area using direct mail solicitation. Only vehicles with over 60,000 miles were sought. This resulted in an average odometer reading for the fleet of 71,410. The tests performed included the Federal Test Procedure, the Highway Fuel Economy Test and several short tests. The program began in July, 1983 and was completed in November, 1983.

The results of this program indicate that some of these vehicles are capable of maintaining low emission levels although high levels are also possible due to emission control component failure, engine wear, deterioration and tampering. The average emission test results were significantly higher than the standards under which they were certified and somewhat higher than the averages of comparable in-use vehicles at lower mileages. The data indicate 80%, 72% and 45% of the cars were above the Federal standards for HC, CO, and NO_x, respectively and 35%, 35% and 15% exceeded twice the standards for HC, CO and NO_x, respectively. City and Highway fuel economy values were also found to be lower than those published in the 1981 Gas Mileage Guide.

Introduction

Few data are currently available on late model, in-use vehicles beyond the 50,000 mile "useful life" defined by Federal Regulations. Because approximately half of the passenger cars registered today have passed that point, this category of vehicles has a significant impact on ambient air quality. In this project, emission data were collected on a sample of 1981 model year vehicles which have exceeded 60,000 odometer miles. The test results will be used to support estimates of future emission levels from vehicles with this type of control technology.

Purpose

The purpose of this program was four-fold:

1. To gather advanced information on high mileage vehicles in order to better predict future emissions from vehicles which have accumulated mileage at a more normal rate.

2. To identify weaknesses and potential failure areas in emission control systems so that the effectiveness of the regulatory process can be enhanced.

3. To provide information for development and improvement of inspection/maintenance programs.

4. To provide information regarding the capability of restorative maintenance to reduce emission levels.

Program Design

This work was performed by Automotive Testing Laboratories (ATL) at the Transportation Research Center of Ohio under EPA Contract No. 68-03-3157. Forty vehicles of the 1981 model year with over 60,000 miles were sought at random from a direct mailing. The vehicles selected were in customer use and were tested "as-received" in order to reflect differences in usage, maintenance and repair. Vehicles which failed their as-received test by over 200% received an R/M sequence. Names and addresses of owners of 1981 model year passenger cars in the area of Columbus, Ohio were purchased from R.L. Polk Co. Solicitation packages were mailed to 6,162 owners at random. The package included a letter and a postpaid reply card with which an owner could report certain vehicle information and express his willingness to participate. A copy of this package is included as Appendix A. Since we were seeking vehicles with the highest mileage, ATL ranked the positive responses by odometer reading. No attempt was made to procure a sample which represented national sales. Owners of vehicles with the highest readings were contacted and offered an incentive package consisting of a $100 Savings Bond, a loan car and a full tank of fuel upon return of their vehicle. ATL also offered to exchange cars at the owner's convenience and promised a summary of the test results on their vehicle.

At the initial meeting, the principal driver was asked to complete a short questionnaire and fill out several forms related to the exchange of vehicles. Examples of these are included as Appendix B.

Once each vehicle was acquired, an ATL technician prepared it for testing. Fluid levels were checked and corrected but no other underhood activities were conducted. A sample of the drained fuel was analyzed for lead content. Preconditioning consisted of the first 505 seconds of the Federal Driving Cycle on the dynamometer or driving for 10 minutes on city streets. This was followed by a 12-24 hour soak period.

Each vehicle was tested as-received in the following sequence:

1. Federal Test Procedure (without heat-build or measurement of evaporative emissions).

2. "Bagged Idle" test. During this three minute idle test the exhaust emissions are gathered through the CVS. The FTP instruments are used to analyze the diluted sample.

3. "50 MPH Cruise" Test. This short cycle employs garage instruments to measure tailpipe concentrations of HC and CO during the 50 mph preconditioning for the HFET.

4. Highway Fuel Economy Test.

5. Four-Mode Idle Test. This short test is comprised of four steady state modes: Idle in neutral, 2500 rpm in neutral, idle in neutral, and idle in drive. Garage instruments are used to sample tailpipe concentrations of HC and CO for each mode.

6. Loaded Two-Mode Test. Sampling is done as before using garage instruments. The first mode is 30 mph at 9 actual dynamometer horsepower. The second mode is idle in neutral.

7. Restart Idle Test. This idle test consists of two operating modes. At the end of the 6-minute idle period, the engine is shut off. The vehicle is immediately restarted using the hot-start procedure and the engine is brought up to 2500 rpm ($\pm$300 rpm). Emissions are measured within 30 seconds. The engine is then returned to idle neutral and idle emissions are measured within 30 seconds. Garage instruments are used to sample tailpipe concentrations of HC and CO for each mode.

8. A complete underhood inspection was performed after the emission tests.

9. Vehicles which failed their as-received emission test by over 200% received restorative maintenance and were retested.

The FTP and HFET data are used for comparison with certified emission levels and to help project future levels of air quality due to vehicles of the 1981 model year. The inspections and short cycles provide information for development and improvement of Inspection/Maintenance programs.

Results

The program began in July, 1983. It was conducted sucessfully in accordance with the design and was completed in November, 1983.

Of the 6,162 solicitation packages sent out, responses were received from 3004 owners. This total of 49 percent was 11 percent higher than in our 1980 model year vehicle program but consistent with the approximately 50 percent response rate experienced in other similar programs. No follow-ups, either by mail or phone, were part of the plan.

Figure 1 displays the number and type of responses versus time. Eighty-two percent of the responses were received within nine days of the mailing. Of the total responses, 66 percent indicated a willingness to participate in our program, although, because of the mileage requirement, only one percent were both willing and able to participate. Only acceptable vehicles with over 60,000 miles were tested with an average odometer reading for the fleet of 71,410.

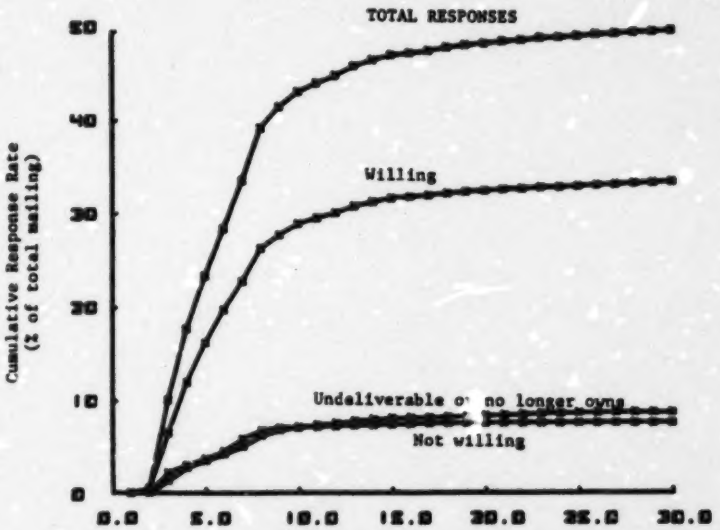


Figure 1. Response Rate Versus Time

Although no attempt was made to procure a sample which represented national sales, the fleet tested reasonably reflects the national population for the 1981 model year as reported by the Automotive News. While there were some shortages of General Motors, Ford, and miscellaneous imports and an over-representation of Chrysler, Toyota and

Honda these were probably due to the relative strengths of dealers in the Columbus area. Table 1 presents the sample share versus the market share.

Table 1
Sample Share versus Market Share (1981 Model Year)

	Sample	Market
General Motors	35%	45%
Ford	10	16
Chrysler	17	9
AMC	0	2
Datsun	8	6
Honda	8	4
VW	2	2
Toyota	20	7
Misc. Imports	0	9
	100%	100%

Emission Test Results

A summary of the results from the FTP and HFET tests are shown in Table 2. FTP and HFET results for each vehicle are attached as Appendix C. FTP results for individual pollutants are displayed in ranked order in Figures 2 through 4.

Table 2
Average Test Results versus Standards

			FTP Emissions				Fuel Economy % of Guide	
	N	Odom	HC	CO	NOx	% Pass	FTP	HFET
This program	40	71,410	0.96	9.9	1.27	18	90	92
Stds/Guide	-	--	.41	3.4*	1.0	100	100	100

Note: Emission results are in grams per mile, fuel economy is in miles per gallon.

*Some vehicles received CO waiver to 7.0 (gm/mi)

Figure 2. FTP HC Levels in Ascending Order

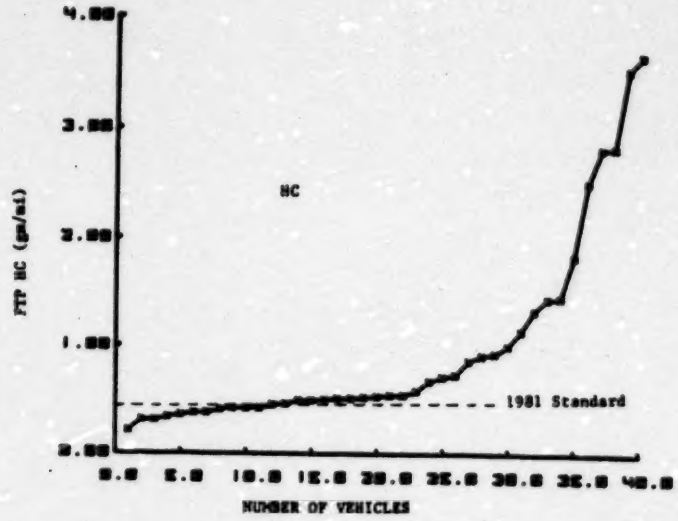


Figure 3. FTP CO Levels in Ascending Order

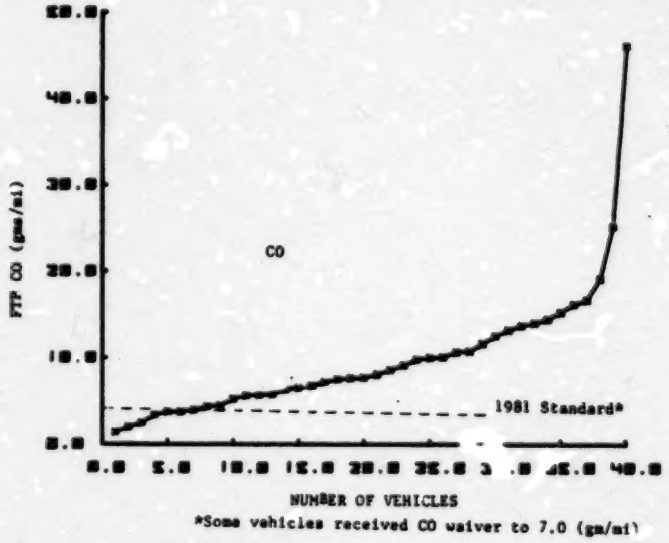
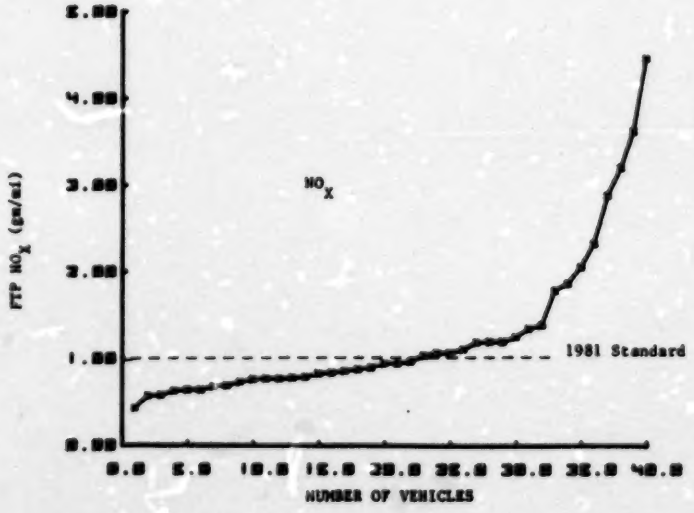


Figure 4. FTP NOx Levels in Ascending Order



Miles-per-gallon (mpg) figures for both the FTP and HFET were calculated. The average fuel economy was compared to the appropriate values listed in EPA's 1981 Gas Mileage Guide. Figures 5 and 6 are histograms of fuel economy as a percent of guide value. The distribution of the values appear to be reasonable and consistent with the results of earlier work.

Idle vs. FTP Emissions

As can be expected, there was a reasonable correlation between results of the FTP and the results of the idle test. Shown in Figures 7 and 8 are plots of FTP emission levels versus results of a basic idle test. Using the typical cutpoints of 250 ppm for HC and 2.5% for CO, Table 3 displays the amount of excess FTP emissions identified by the Idle Test. Excess emissions are the amount of FTP emissions above certification levels.

Table 3
Excess FTP Emissions Identified by the Idle Test
1981 MY High Mileage Passenger Cars (N=40)

	HC gm/mi			CO gm/mi		
	N	Avg.	%	N	Avg	%
Total Excess FTP Emissions	32	0.71	100	29	7.05	100
Failed 4 Mode Idle Test	0	-	0	2	25.08	24
Passed 4 Mode Idle Test*	40	0.57	100	38	4.06	76

* 2nd Neutral of 4 Mode Idle 250ppm, HC and 2.50% CO

Underhood Inspection

Each of the vehicles was tested in "as-received" condition to gather data representative of normal use. An underhood inspection of emission related components and adjustments was also conducted to evaluate the degree of any maladjustments, disablements, inadequate maintenance, defects, unusual deterioration or misbuilds. Any abnormal physical condition or a measured value outside an allowable range was coded as a failure.

Results from past programs have shown that vehicles which are in proper operating order normally produce the lowest emission levels. Six of the vehicles in this effort were found to be in proper order and although only two passed their emission standards, all six were low emitters. A summary of these findings is contained in Appendix D. Typical problems include basic timing, idle speed, choke settings, PCV valve plugging and EGR tampering.

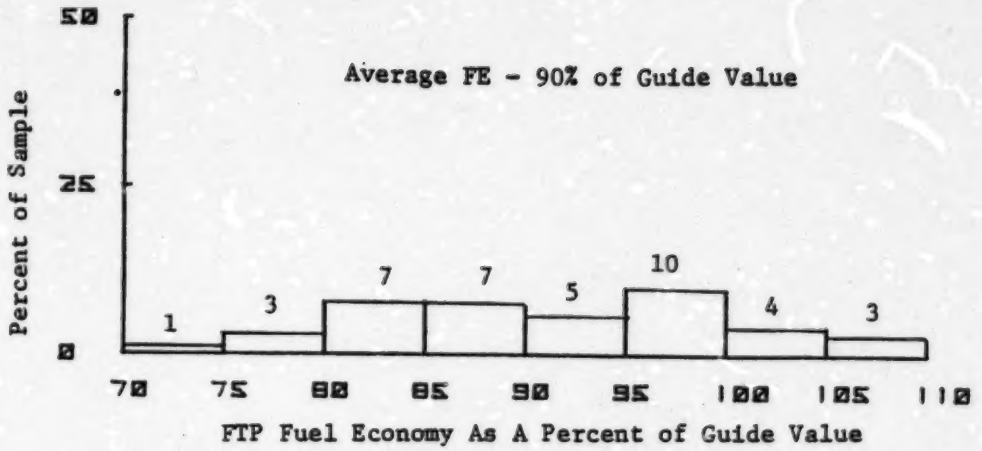


Figure 5. Histogram of FTP Fuel Economy Values

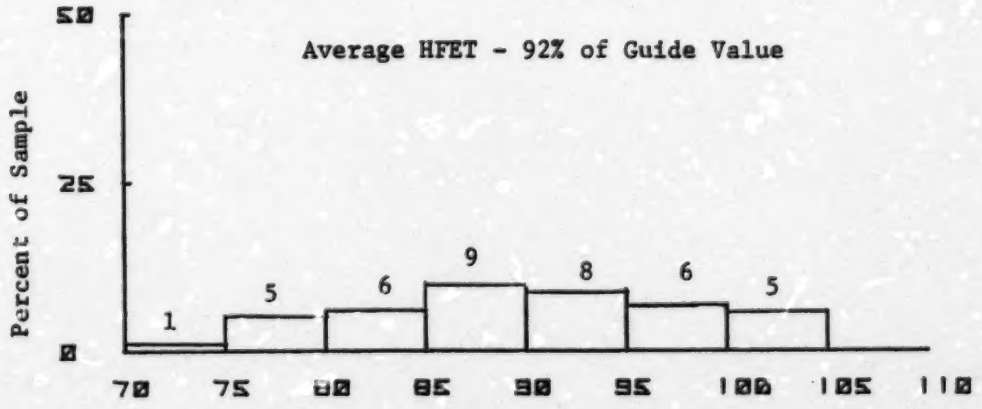


Figure 6. Histogram of HFET Fuel Economy Values

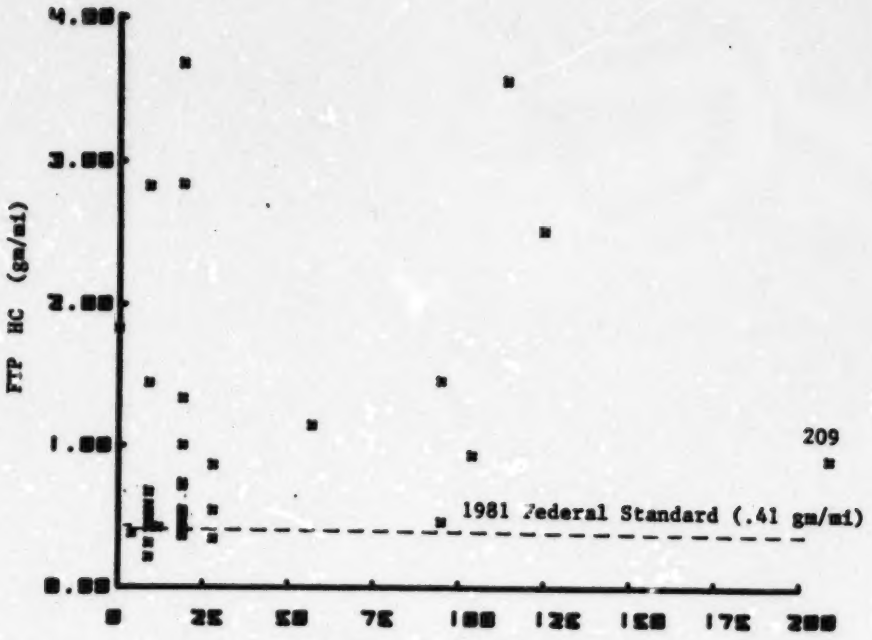


Figure 7. Results of Idle Test Versus FTP Values for HC

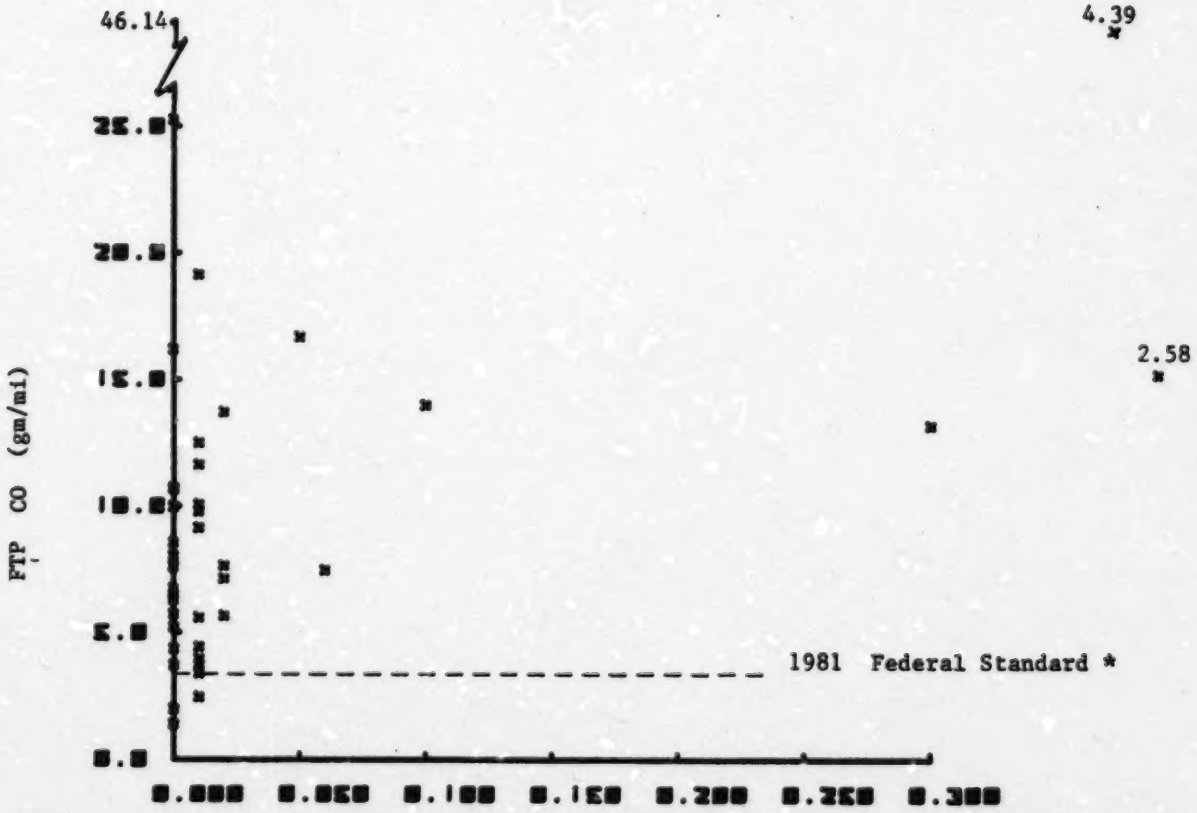


Figure 8. Results of Idle Test Versus FTP Values for CO

* Some vehicles received CO waiver to 7.0 (gm/mi)

Misfueling

Fuel samples were drawn from each of the vehicles and examined for lead content. In addition, filler necks were examined and the PLUMBTESMO (lead sensitive paper applied to the tailpipe) test was conducted. None of the vehicles were found to show positive signs of using leaded fuel. No filler necks were found to be altered. This was not considered unusual in that the proportion of all vehicles which have been misfueled might not be properly represented in a voluntary program sponsored by EPA.

Comparison With Results of Other Programs

EPA has conducted several test programs which sampled comparable 1981 models. During these earlier programs, 367 vehicles from the 1981 model year were tested. The average mileage for this sample was 11,133 miles. Of this sample, 56% met their standard with average HC and CO levels slightly above the standard. Average NO_x emissions were below the standard. These results are listed in Table 4 and are plotted in Figures 9-11.

Other results were obtained from recent programs known as EF-I & EF-II. These programs included 366 vehicles from the 1981 model year which were tested at EPA's Ann Arbor facility. A random sample drawn from within 20 miles of Ann Arbor was obtained using the State of Michigan registration list. The testing was completed in 1983. Results from this program are also listed in Table 4 and plotted in Figures 9-11.

As can be seen from Table 4, the average emission levels of these vehicles show a definite trend toward higher levels as the vehicles accumulate mileage. Restorative maintenance indicated the primary causes for these differences can be attributed to deterioration of the engine or problems with the control systems.

Table 4
Average Test Results From Three Sources
of Emission Factor Data

			FTP			%	Fuel Economy	
	N	Odom	HC	CO	NOx	Pass	FTP	HFET
Earlier EF	367	11,133	.49	6.1	.73	56	89	90
Ann Arbor (EF1,2)	366	33,102	.62	8.4	.86	32	94	97
This program	40	71,410	.96	9.9	1.27	18	90	92

Note: Emission results are in grams per mile, fuel economy is in percent of 1981 Gas Mileage Guide Value.

Figure 9. Relationship of Average HC Levels to Odometer Reading

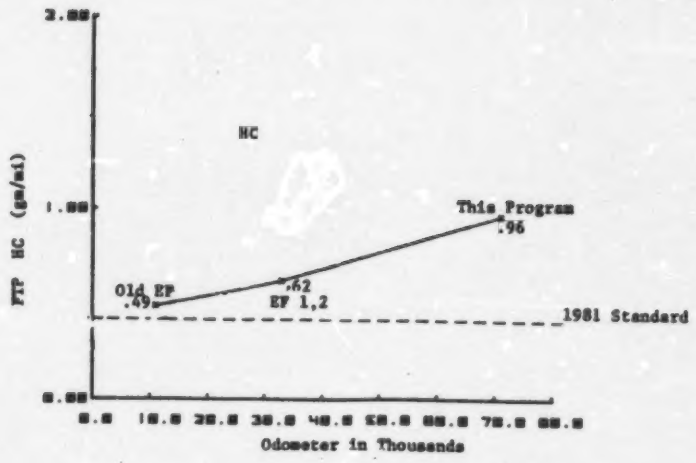
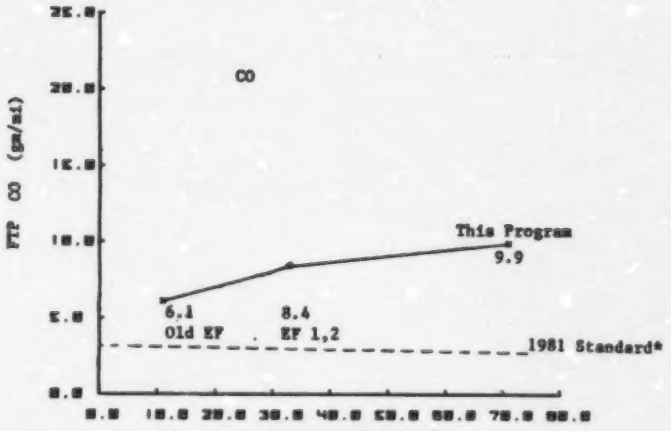
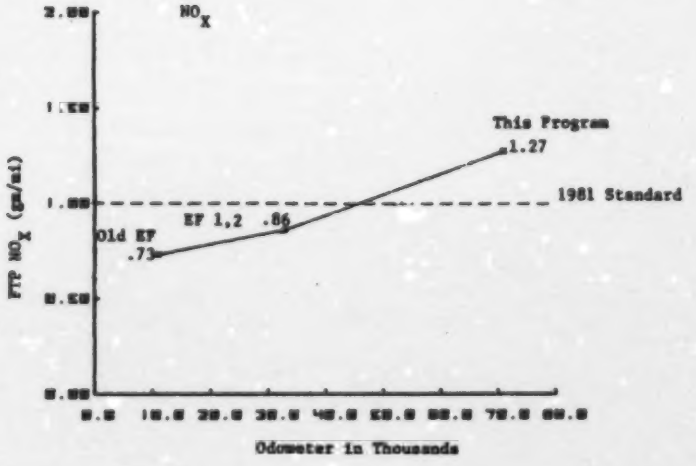


Figure 10. Relationship of Average CO Levels to Odometer Reading



* Some vehicles received CO waiver to 7.0 (gm/mi)

Figure 11. Relationship of Average NOx Levels to Odometer Reading



Conclusions

The results of this program indicate that some of these vehicles are capable of maintaining low emission levels although high levels are also possible due to emission control component failure, engine wear, deterioration and tampering. The average emission test results of these high-mileage 1981 models were significantly higher than those resulting from the EPA Certification tests. Considering the results from other studies on 1981 models at lower mileage, there is also a clear trend toward increasing emission levels with age, mileage and the associated degradation of components and adjustments. The data indicate 80%, 72% and 45% of the cars were above the Federal standards for HC, CO, and NO_x, respectively and only 35%, 35% and 15% exceeded twice the standards for HC, CO, and NO_x, respectively. City and Highway fuel economy values were also found to be significantly lower than those published in the 1981 Gas Mileage Guide.

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and
Automotive Testing Laboratories, Inc.
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East Liberty, Ohio 43319

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Odometer reading _____ miles
(Please fill in odometer reading whether or not you choose to participate)

- ☐ Yes, I am interested in this program.
- ☐ Sorry, I have chosen not to participate.
- ☐ I would like more information.
- ☐ I no longer own a 1981 vehicle.

Telephone _____ Best time to call _____

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

Dear Vehicle Owner:

The Environmental Protection Agency is conducting an important air pollution study. The actual work will be performed under contract by Automotive Testing Laboratories (ATL) at the Transportation Research Center of Ohio. You have been selected as a possible participant in this program, in which an official EPA fuel economy and emissions test would be performed on your vehicle. You may be able to help us and be rewarded for your cooperation.

Our current program involves 1981 vehicles with high odometer readings. If your vehicle qualifies, we will offer you the following incentives to participate:

1. The use of a late-model, fully insured loaner car with a full tank of fuel. We will exchange vehicles at a time and place of your choice.
2. A $100 U.S. Savings Bond.
3. Return of your vehicle with a full tank of fuel.
4. The results of the emission and fuel economy tests.

No unusual operations will be performed on your vehicle and it will be fully insured for the entire test period, which will take approximately one week. If you are willing to participate, a representative of ATL will be in touch with you to ask questions about your vehicle.

Please complete and return the enclosed postpaid reply card as soon as possible, even if you choose not to participate or if your odometer reading is not high. Other programs are planned for which you may be eligible.

The enclosed information sheet answers questions people often ask about this program. If you have any additional questions, please feel free to call Priscilla Bruce of ATL at 221-0336 or John Shelton of my staff at (313) 668-4200. They will be able to answer any questions you may have.

We look forward to receiving your reply card or a telephone call very soon.

Sincerely,

Ralph C Stahman

Ralph C. Stahman, Chief
Test and Evaluation Branch

Enclosures

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

MOTOR VEHICLE EMISSION TESTING PROGRAMS

OFFICE OF
AIR, NOISE AND RADIATION

Questions and Answers

1. **Must I participate in this program?**

   No, your cooperation in this program is completely voluntary. If, for any reason, you decide not to participate, please let us know on the enclosed postpaid reply card.

2. **Why should I participate?**

   In addition to a $100.00 U.S. Savings Bond, a loaner vehicle and a full tank of gasoline, your participation will benefit you indirectly by helping EPA understand and improve the quality of the air in and around your city.

3. **How long will the test program take?**

   The test program takes approximately 1 week. The length of time is dependent on how many other cars are being tested.

4. **Will my vehicle be mistreated in any way?**

   No, every aspect of the test program has been designed to duplicate everyday operation.

5. **Exactly what will be done to my vehicle?**

   A complete underhood inspection will be performed. The vehicle must be commpletely cooled off before the test can begin. This requires that the vehicle not be started for 12 to 36 hours to simulate overnight parking. Once the vehicle is sufficiently cooled off, it will be pushed onto a dynamometer. Although the vehicle doesn't actually move during the test, the dynamometer is a type of treadmill which simulates conditions which would normally be encountered on the road. A hose is connected to the exhaust pipe to collect the exhaust. A specially trained driver then starts the vehicle and "drives" it through a "driving cycle" which represents typical operation in urban, suburban and rural areas. Throughout this time, a portion of the exhaust gases is collected for subsequent exhaust analysis. This analysis allows us to calculate the quantity of exhaust emissions emitted by your vehicle. Values for the city and highway fuel economy are also calculated.

(over)

6. How many miles will my vehicle be driven during the program?

Your vehicle will be driven approximately 100 odometer miles during the testing. The majority of these miles will be accumulated indoors on the dynamometer. A 10 minute road test might precede the dynamometer testing.

7. How will my vehicle be protected while in your possession?

In addition to providing insurance, we will store your vehicle indoors while the testing is being conducted. If required to be parked outside, your vehicle will be located in a locked and secure area at ATL's Motor Vehicle Emission Laboratory which is located at the Ohio Transportation Research Center in East Liberty, Ohio.

8. What happens to the information obtained from my vehicle?

The information collected as a result of this program is used to determine the emissions performance of in-use vehicles and its effect on air quality. The data from your vehicle are combined with data from other vehicles in this area in order to obtain a statistically valid sample.

9. How can I obtain the results from the testing of my vehicle?

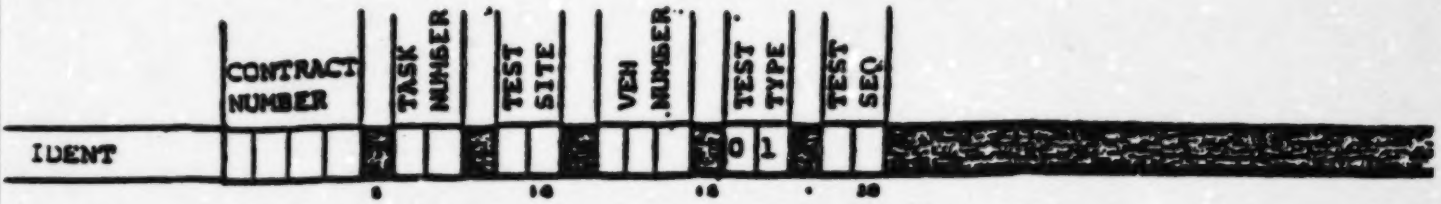
If you request, after the completion of the testing you can obtain the results on your vehicle. We will forward them to you as soon as all the data have been processed.

10. What happens if my vehicle fails to meet any emission standards?

We expect that a certain proportion of the vehicles will fail to meet one or more of the emission standards. However, none of the information collected from this program will be used against individual vehicle owners.

VEHICLE OWNER QUESTIONNAIRE
DATA SHEET

APPENDIX B



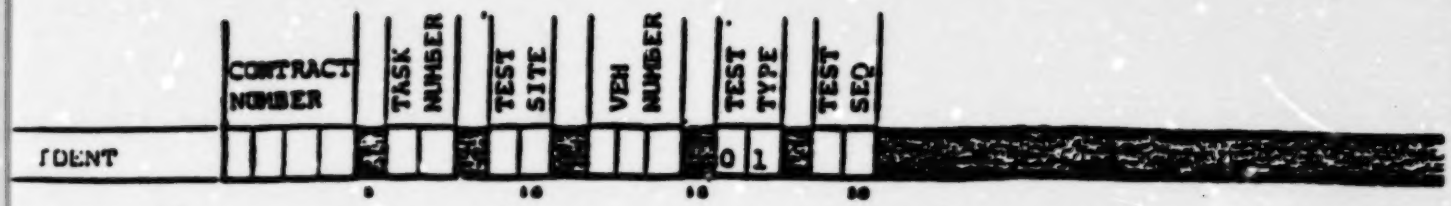
1) What is the brand name of the fuel you normally use (see list below)?	
2) Have you, or others, ever noticed a hydrogen sulfide (rotten eggs) odor in the vehicle exhaust?	1 (never) 2 (seldom) 3 (occasionally) 4 (frequently) 5 (don't know)
3) Have you ever used gasohol in this vehicle?	1 (never) 2 (seldom) 3 (occasionally) 4 (frequently) 5 (don't know)
4) If you have used gasohol, a) Have you noticed any difference in the vehicle performance?	1 (never used gasohol) 2 (perf. is better) 3 (perf. is worse) 4 (no difference) 5 (don't know)
b) Have you noticed any difference in fuel economy?	1 (never used gasohol) 2 (fuel economy better) 3 (fuel economy worse) 4 (no difference) 5 (don't know)
5) How long ago did you purchase the vehicle to be tested?	1 (0-3 months) 2 (3-12 months) 3 (1-2 years) 4 (over 2 years)

DATA ENTRIES FOR QUESTION #1

ENTER	BRAND NAME	ENTER	BRAND NAME	ENTER	BRAND NAME	ENTER	BRAND NAME	ENTER	BRAND NAME	ENTER	BRAND NAM
AMOC	AMOCO	CLAR	CLARK	FINA	FINA	MOBI	MOBIL	SHEL	SHELL	UNIO	UNION
ARCO	ARCO	CONO	CONOCO	GENC	GENCO	MOTO	MOTOR	SINC	SINCLAIR	VICK	VICKERS
ASHL	ASHLAND	CROW	CROWN	GULF	GULF	PENN	PENNZOIL	SITE	SITE	WARD	WARDS
BONA	BONAFIDE	DERB	DERBY	HESS	HESS	PHIL	PHILLIPS	SKEL	SKELLY	ZEPH	ZEPHYR
BP	BP	ENCO	ENCO	HUDS	HUDSON	SCOT	SCOTT	STAN	STANDARD	**	OTHER
CHEV	CHEVRON	ESSO	ESSO	MARS	MARS	SEAR	SEARS	SUNO	SUNOCO	UNKN	UNKNOWN
CITC	CITCO	EXXO	EXXON	MART	MARTIN	SHAM	SHAMROCK	TEXA	TEXACO	VARI	VARIOUS

** IF BRAND IS 'OTHER', THEN ENTER THE FULL BRAND NAME VEHICLE OWNER USES.

VEHICLE OWNER QUESTIONNAIRE
DATA SHEET



6) On a yearly basis, how many thousands of miles is this vehicle driven?		1 (0-5) 2 (5-10) 3 (10-15) 4 (15-20) 5 (20-30) 6 (over 30)
7) Where is the driving done? almost all: > 75% most: 75-51% some: 50-21% little or none: < 20%	a) City expressways	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	b) Major city streets	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	c) Other city streets	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	d) Rural expressways	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	e) Other rural roads	1 (almost all) 2 (most) 3 (some) 4 (little or none)
8) How is the driving done? almost all: > 75% most: 75-51% some: 50-21% little or none: < 20%	a) To and from work	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	b) Shopping and errands	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	c) Business (not to and from work)	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	d) Other (social, vacations, etc.)	1 (almost all) 2 (most) 3 (some) 4 (little or none)
9) How did you get here today?		1 (city streets only) 2 (some expressway) 3 (primarily expressways)
	Approx. miles	[ ][ ] .

VEHICLE OWNER QUESTIONNAIRE
DATA SHEET

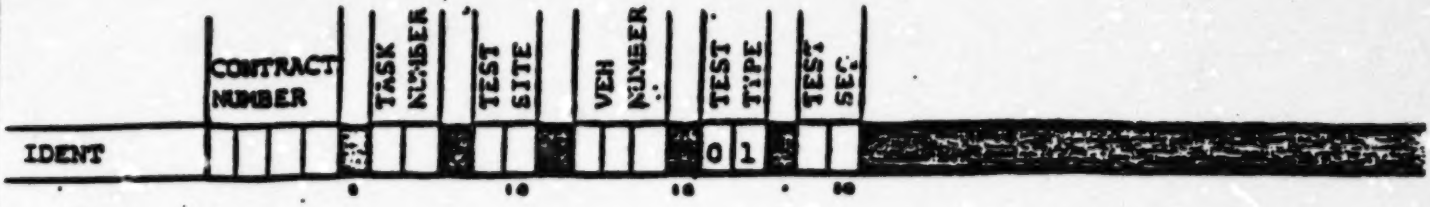
	CONTRACT NUMBER		TASK NUMBER		TEST SITE		VEH NUMBER		TEST TYPE		TEST SEQ	
IDENT									0	1		

10) How is this vehicle used? almost all: > 75% most: 75-51% some: 50-21% little or none: < 20%.	a) Driver only	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	b) Driver and one passenger	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	c) Driver and 2 or more passengers	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	d) Driver only with heavy cargo	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	e) Driver, passenger and cargo	1 (almost all) 2 (most) 3 (some) 4 (little or none)
	f) Towing a trailer	1 (almost all) 2 (most) 3 (some) 4 (little or none)
11) On a typical day, how many trips are made with this vehicle? (One trip is defined as starting the engine, traveling some distance and stopping the engine).		☐☐
12) On a weekly basis, how often is full throttle acceleration used?		1 (seldom) 2 (once or twice) 3 (3-6 times) 4 (every day)
13) Do you now experience any engine performance problems with this vehicle?	a) Hard starting	1 (yes) 2 (no)
	b) Stalling	1 (yes) 2 (no)
	c) Rough idle	1 (yes) 2 (no)
	d) Engine misfiring	1 (yes) 2 (no)
	e) Poor acceleration	1 (yes) 2 (no)
	f) Stumbling	1 (yes) 2 (no)
	g) Hesitation	1 (yes) 2 (no)
	h) Engine knock or ping	1 (yes) 2 (no)
	i) Dieseling (after run)	1 (yes) 2 (no)

VEHICLE OWNER QUESTIONNAIRE
DATA SHEET

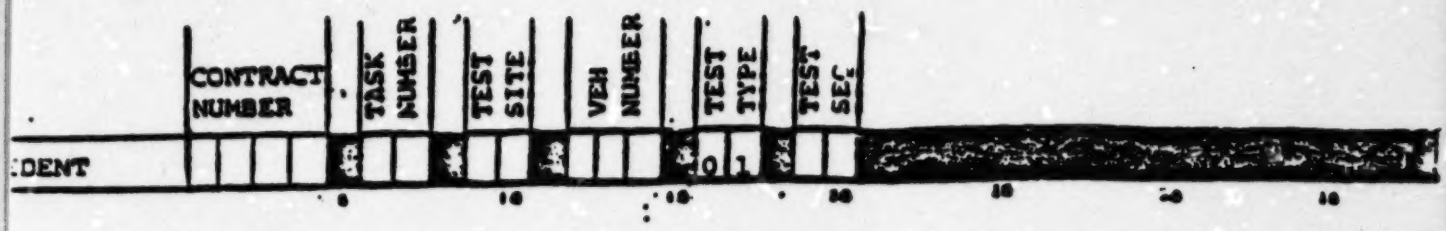
14)	Overall, are you reasonably satisfied with the engine performance of this vehicle?	1 (yes) 2 (most of the time) 3 (no)
15)	How long ago was the last oil change?	1 (too new, not due) 2 (due, but not yet done) 3 (0-6 months ago) 4 (6-12 months ago) 5 (Over 1 year ago) 6 (don't know)
16)	If you purchased the vehicle under warranty, how many times has it been returned for warranty repairs?	1 (no warranty) 2 (never returned) 3 (twice) 4 (3 or more) 5 (don't know)
17)	What was the nature of the warranty repair?	1 (no warranty) 2 (never returned) 3 (recall) 4 (driveability) 5 (other)
18)	Have you had any repairs to your vehicle for the correction of driveability problems?	1 (yes) 2 (no problems)
19)	What repairs were performed on your vehicle to correct the driveability problems? Specify _____	1 (none) 2 (carburetor) 3 (engine) 4 (emission control system) 5 (ignition system) 6 (other) 7 (don't know)
20)	How long ago were these repairs accomplished?	1 (no repairs) 2 (0-3 months) 3 (3-6 months) 4 (over 6 months) 5 (don't know)
21)	Were these repairs effective in correcting the driveability problems?	1 (no repairs) 2 (yes) 3 (no)
22)	Is this vehicle operated regularly on unpaved roads, in competitive events, or in hauling or transporting loads heavier than for which it was designed?	1 (yes) 2 (no) 3 (don't know)

VEHICLE OWNER QUESTIONNAIRE
DATA SHEET

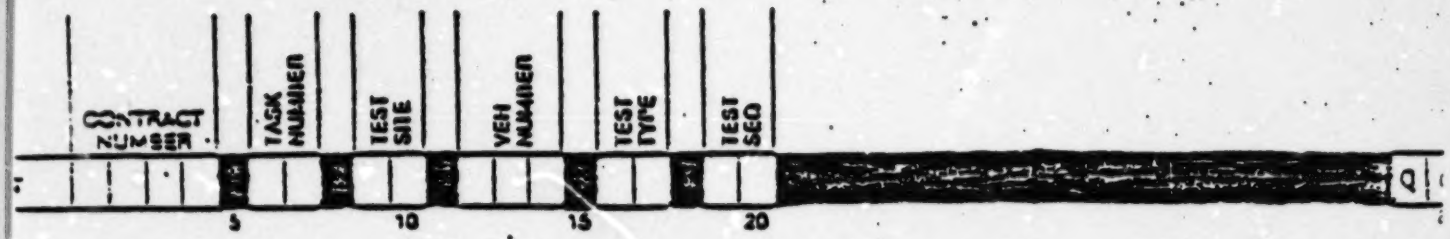


23) Has the vehicle ever had major damage in any of the following areas?	a) Engine	1 (yes) 2 (no)
	b) Cooling system	1 (yes) 2 (no)
	c) Fuel system	1 (yes) 2 (no)
	d) Exhaust system	1 (yes) 2 (no)
	e) No damage	1 (yes) 2 (no)
	f) Don't know	1 (yes) 2 (no)
24) Has the catalytic converter ever been replaced on this vehicle?		1 (no catalyst) 2 (yes) 3 (no) 4 (don't know)
25) Was the vehicle tested in a previous EPA program?		1 (yes) 2 (no)
26) Has any maintenance performed since the last test?		1 (yes) 2 (no) 3 (not tested)
27) What type of maintenance was performed?		1 (warranty) 2 (tune-up) 3 (none) 4 (not tested)
28) How much did the maintenance cost? 001 : no maintenance 000: don't know 0UU: not tested		☐☐☐
29) Who performed the maintenance?		1 (no maintenance) 2 (dealer) 3 (independent garage) 4 (tune-up clinic) 5 (yourself) 6 (not tested)

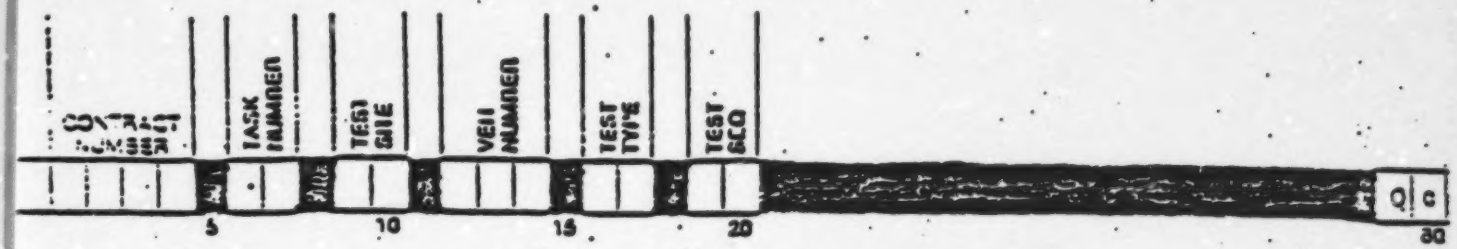
VEHICLE OWNER QUESTIONNAIRE
DATA SHEET



30)	Do you accurately keep records of the fuel economy on this vehicle?	1 (yes) 2 (no)
31)	Are you concerned with the fuel economy of this vehicle?	1 (yes) 2 (no)
32)	Date of last city or state emissions inspection. 99/99 : don't know 88/88 : not required 00/00 : never inspected	a) Month b) Year
33)	Did your vehicle pass or fail the inspection?	1 (pass) 2 (fail) 3 (don't know) 4 (not required) 5 (never inspected)
34)	a) Does your odometer indicate the true number of miles on your car?	1 (yes) 2 (no)
	b) If no, specify approximate total number of miles this vehicle has been driven.	



A)	How often is the car we are testing tuned up?	1 (at least every six) months) 2 (7 to 12 months) 3 (Less often than once per year) 4 (According to owners manual) 5 (Too new to be tuned) 6 ("When Needed") 7 (Other) 8 (Don't Know) 9 (Not Applicable)	(1)
B)	How long ago was the last tune up?	1 (6 months or less) 2 (7 to 12 months) 3 (longer than 12 months) 8 (Don't Know) 9 (Not Applicable)	(2)
C)	Who did the last tune up?	1 (car dealer) 2 (service station) 3 (independent garage) 4 (self or other family member) 7 (Other) 8 (Don't Know) 9 (Not Applicable)	(3)
D)	We are interested in the fuel economy people actually get with their cars. How many miles per gallon do you get with this car? (Enter "98" if Don't Know) (Enter "99" if Not Applicable)	a) in the city?	(4-5)
		b) on the highway	(6-7)
		c) combined city & highway	(8-9)



E)	Has unleaded gasoline usually been used in this car?		1 (Yes) 2 (No) 8 (Don't Know) 9 (Not Applicable)	(10)
F)	Unleaded gas is more expensive than leaded and at times has been hard to find.	a) Have you ever used leaded gasoline in this car?	1 (yes) 2 (no) 8 (don't know) 9 (Not Applicable)	(11)
		b) If yes, how often?	50 (50 or more) 51 (Never) 52 (Seldom) 53 (Occasionally) 54 (Frequently) 99 (Don't Know or not Applicable)	(12-13)

Q 12 | 80

TEST NO.: F-8001 VEHICLE NO.: 279

CUSTOMER CONTRACT

NAME: Mr Thomas E Harron
ADDRESS: 151 Midgard Rd
CITY: Columbus STATE: Ohio ZIP CODE: 43202
HOME PHONE: 268-2156 WORK PHONE: 1-800-323-0208
DATE/TIME-IN: _____ DATE/TIME-OUT: _____

BOND INFORMATION

OWNER: Thomas Eugene Harron S.S. #: 291-58-2152
ADDRESS: 151 Midgard Rd
CITY: Columbus STATE: Ohio ZIP: 43202
CO-OWNER OR BENEFICIARY: Lisa L. Harron
NUMBER OF BONDS: 1 DENOMINATION: $100

OFFICE USE
PAGE _____
DATE _____
BY _____

VEHICLE INSPECTION

	PAINT OK	PAINT CHIPS	OTHER		PAINT OK	PAINT CHIPS	OTHER
LEFT REAR FENDER	✓			REAR END	✓		
LEFT DOORS	✓			REAR BUMPER	✓		
LEFT FRONT FENDER	✓			TOP	✓		
HOOD	✓			WINDOW GLASS	✓		
GRILL	✓			ANTENNA	✓		
FRONT BUMPER	✓			HUB CAPS	✓		
RIGHT FRONT FENDER	✓			MIRRORS	✓		
RIGHT DOORS	✓			INTERIOR	✓		
RIGHT REAR FENDER			Dent	TAPE DECK/CB	YES (NO)		
TRUNK LID	✓			LICENSE NO.	NEW 9UB		
BODY STYLE	2DR (4DR) SED WAG			TIRE MFR.	FIRE11		
VIN	2G3AR69A1B241[illegible]			TIRE SIZE	P19/75R14		
ODOMETER	67797			TIRE CONDITION	DON'T TEST ROTATE (OK)		
ENGINE FAMILY	145TM			EXHAUST LEAK	DON'T TEST REPAIR (OK)		
CERTIFICATION	FED CAL ALT OTH			INSP. INITIALS	KL		

AMENDMENTS &/OR COMMENTS: _____
AGREED TO: 5-29 83 [DATE], BY JKH [INITIALS]

CONDITION WHEN RETURNED

ODOMETER: _____ DATE: _____
CONDITION: _____ INITIALS: _____

Automotive Testing Laboratories,Inc.
P.O. Box 289, East Liberty, OH 43319

PARTICIPANT VEHICLE NO. 279 27

VEHICLE EXCHANGE AGREEMENT

Automotive Testing Laboratories, Inc. (ATL) is furnishing you a Ford Fairmont (Model-Year) 1982 (Make, Model) Dag-13 (Lic.#) as a temporary substitute vehicle or a replacement for your Oldsmobile (Model-Year) Cutlass (Make, Model) MEW-944 (Lic.#) subject to the following terms and conditions:

You agree to be careful in the use of the loan vehicle and agree to return it to ATL within 7 days, together with all tires, tools and accessories and in as good interior, exterior and operating condition, normal wear and tear excepted, as when it was received by you.

You also agree that it will not be used to carry passengers or property for a consideration or to push or tow any vehicle or trailer. The loan vehicle will be operated only by you or a member of your immediate family provided that your permission is given and all such operators be at least 21 years of age and duly qualified and licensed.

You acknowledge personal liability for all charges, fines and costs for parking, traffic or other legal violations assessed against the loan vehicle while in your possession except where caused through fault of ATL; you further acknowledge liability for any allowable legal fees incurred by ATL collecting payment hereunder.

You agree to release and hold ATL harmless from any liability for loss of, or damage to, any property left, stored or transported in vehicle by you or any other person during or following the term of this agreement.

ATL, in turn, agrees to be fully responsible for any and all damage occurring to your vehicle while in ATL's possession. Such possession is hereby defined as care, control, custody, operation, inspection or storage between the time the vehicle is received from you and the time it is returned.

ATL also agrees to indemnify and hold you harmless of any repairs, damage, loss or liability sustained by you by reason of accident or damage to your vehicle while in ATL's possession.

ATL further agrees to be careful in the use of your vehicle and agrees to return it to you in as good interior, exterior and operating condition, normal wear and tear excepted, as when it was received by ATL.

In consideration of 100.00 Bond I agree to loan my vehicle to ATL for a time period not to exceed 7 days unless otherwise agreed to. I understand I am at liberty to demand the return of my vehicle at any time and that ATL is obligated to honor such and return my vehicle within a reasonable period of time regardless of the status of testing. If in the opinion of ATL my vehicle is unfit for testing, I waive consideration as specified above.

Agreed to this date, 8/26/82, by

Myron W. Gallogly, President and Vehicle Owner

Drivers lic. # I20059[illegible] State Ohio Expires 5/87

PROJECT # 088-4

Appendix C
Testing of High Mileage 1981 Passenger Cars
Results of FTP and Highway Fuel Economy Tests

					FTP					HFET					Idle Test	
VEH	MAKE	MDL	CID	MILE	HC	CO	NOX	MPG	CYCLE	HC	CO	NOX	F.E.	GUIDE	HC	CO
250	VW	RABB	105	61694	.93	14.41	.86	25.91	25	.16	3.4	.27	41.40	40	104	2.58
251	HOND	CIVI	91	71119	.54	3.37	.90	31.67	34	.09	.2	.85	41.89	44	28	.01
252	BUIC	SKYL	151	61125	2.82	9.77	.95	21.49	22	.04	.1	.46	31.78	33	9	.01
253	TOYO	CELI	144	70744	.51	5.65	.77	22.62	25	.10	1.3	1.06	34.47	37	19	.02
254	CHEV	IMPA	305	70712	1.45	15.21	.97	14.64	18	.09	3.0	.40	24.52	24	95	.39
255	DATS	210	85	63508	.34	6.47	.88	29.97	36	.07	1.3	.85	39.16	47	28	.00
256	PLYM	HORI	105	65114	.91	8.54	2.33	21.52	25	.19	.2	3.96	29.29	35	209	.00
257	CHEV	CHEV	98	69833	.52	7.46	.83	29.06	30	.08	1.1	.98	39.29	39	19	.06
258	HOND	CIVI	91	66359	.42	1.97	1.07	35.75	34	.06	.1	1.03	47.78	44	9	.00
259	DODG	ARIE	156	67729	.49	13.69	.79	22.26	23	.11	6.4	.64	30.28	31	19	.02
260	BUIC	REGA	231	67410	1.33	13.17	.95	19.14	21	.13	2.0	.45	29.22	30	19	.30
261	TOYO	CORO	89	71650	.38	5.58	.64	27.29	34	.07	1.6	.69	37.83	46	19	.01
262	DATS	310	91	87957	.38	5.19	1.20	28.26	32	.09	.3	1.19	38.31	42	19	.00
263	HOND	CIVI	81	67066	.21	1.37	.69	30.90	33	.03	.1	.74	40.04	44	9	.00
264	FORD	THUN	302	65037	2.83	19.11	2.89	15.29	16	.08	.0	4.38	27.56	26	19	.01
265	BUIC	REGA	231	64007	1.14	16.67	3.63	18.57	21	.08	.9	4.55	27.39	30	57	.05
266	MERC	COUG	255	107936	3.67	25.24	1.25	15.65	18	.16	.6	3.17	25.72	25	19	.00
267	BUIC	CENT	231	86713	.67	7.59	4.47	19.06	21	.10	.7	5.20	28.22	30	9	.00
268	TOYO	CORO	89	71632	.31	5.72	.73	29.06	34	.05	.5	1.02	39.64	46	9	.00
269	OLDS	OMEG	151	88390	3.54	12.48	3.21	21.24	24	.10	.2	3.56	30.57	36	114	.01
270	BUIC	CENT	231	61847	.58	13.97	1.04	17.87	21	.05	1.0	.46	24.23	30	9	.10
271	MERC	LYNX	98	61566	.86	9.13	.68	24.45	30	.30	2.5	.68	36.99	44	28	.01
272	PLYM	RELI	135	65847	1.00	6.28	1.11	25.91	25	.05	.3	1.22	39.40	41	19	.00
273	OLDS	DELT	307	76712	.54	2.44	1.35	15.53	17	.13	.2	1.09	25.17	28	19	.01
274	OLDS	CUTL	231	75246	2.51	46.14	.57	14.85	21	.61	8.3	.34	22.01	30	123	4.39
275	PLYM	RELI	156	68225	.51	10.04	2.06	22.84	23	.09	.1	1.20	30.75	31	19	.01
276	OLDS	NINE	307	69719	1.83	11.61	.78	13.37	17	.08	2.6	.54	22.14	28	0	.01
277	TOYO	CORO	89	74104	.42	6.73	.58	27.18	34	.07	1.1	.50	37.07	46	12	.00
278	PONT	LEMA	231	74336	.38	4.42	.77	19.70	21	.05	.3	.50	29.64	30	4	.01
279	OLDS	CUTL	231	67438	.50	7.64	.84	18.34	21	.16	3.7	.31	25.67	30	9	.02
280	DATS	210	85	65575	.46	7.13	.76	29.90	36	.07	1.8	.53	38.30	47	95	.02
281	FORD	ESCO	98	64521	.49	3.95	1.07	23.53	30	.09	.1	1.26	38.06	44	19	.01
282	PLYM	HORI	105	63393	.42	3.71	1.39	29.73	28	.05	.1	1.55	46.87	43	19	.01
283	DODG	ARIE	156	80386	.45	16.16	1.20	23.09	23	.24	15.2	.83	30.11	31	9	.00
284	TOYO	STAR	79	86084	.41	3.69	.63	39.62	39	.06	.4	.75	57.06	54	19	.00
285	TOYO	CELI	144	87240	.31	4.34	.64	19.78	25	.05	1.5	.90	28.04	35	9	.00
286	TOYO	STAR	79	64857	.53	9.96	.43	37.73	39	.07	2.4	.44	53.16	54	9	.00
287	BUIC	SKYL	151	84096	.71	10.71	1.79	21.49	24	.05	.2	1.35	29.83	36	19	.00
288	TOYO	STAR	79	75807	1.44	10.64	1.87	32.41	39	.07	.5	2.78	48.45	54	9	.00
289	PLYM	RELI	135	61684	.73	8.03	1.19	20.93	23	.07	.0	1.39	33.29	34	19	.00

NOTE: Exhaust emissions are in grams per mile while fuel economy is in miles per gallon. Results from the idle test are shown in ppm for HC and in % for CO.

VEH	TEST	PB.F	PB	INDT	FUEL	CHKE	IGNT	EGR	AIRP	PCV	EXHS	EVAP	MISC	TWAY
250	RECV	.005	PASS	PASS	PASS	NA	FAIL	NA	NA	PASS	PASS	PASS	PASS	PASS
250	TST2	.005	PASS	PASS	PASS	NA	FAIL	NA	NA	PASS	PASS	PASS	PASS	PASS
251	RECV	.001	PASS	PASS	PASS	PASS	PASS	PASS	NA	PASS	PASS	PASS	PASS	NA
252	RECV	.004	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
252	TST2	.004	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
253	RECV	.001	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	FAIL
254	RECV	.001	PASS	FAIL	PASS	FAIL	FAIL	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS
254	TST2	.001	PASS	FAIL	PASS	FAIL	FAIL	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS
255	RECV	.007	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	NA
256	RECV	.032	PASS	PASS	FAIL	PASS	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL	FAIL
256	TST2	.032	PASS	PASS	FAIL	PASS	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL	FAIL
257	RECV	.034	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
258	RECV	.017	PASS	PASS	PASS	PASS	PASS	PASS	NA	PASS	PASS	PASS	PASS	NA
259	RECV	.022	PASS	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	NA
260	RECV	.006	PASS	PASS	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	FAIL	FAIL
261	RECV	.012	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	NA
262	RECV	.017	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	NA
263	RECV	.022	PASS	PASS	PASS	PASS	PASS	PASS	NA	FAIL	PASS	PASS	PASS	NA
264	RECV	.005	PASS	PASS	PASS	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS
264	TST2	.005	PASS	PASS	PASS	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS
265	RECV	.005	PASS	PASS	FAIL	PASS	FAIL	FAIL	FAIL	PASS	PASS	FAIL	PASS	PASS
266	RECV	.008	PASS	PASS	FAIL	FAIL	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS
266	TST2	.008	PASS	PASS	FAIL	FAIL	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS
267	RECV	.001	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS
268	RECV	.006	PASS	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	NA
269	RECV	.014	PASS	FAIL	PASS	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	FAIL
270	RECV	.004	PASS	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS
271	RECV	.001	PASS	PASS	FAIL	FAIL	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS
272	RECV	.016	PASS	PASS	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS
272	TST2	.016	PASS	PASS	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS
273	RECV	.002	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
274	RECV	.008	PASS	FAIL	FAIL	FAIL	FAIL	PASS	FAIL	FAIL	PASS	PASS	PASS	PASS
275	RECV	.015	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	NA
276	RECV	.015	PASS	PASS	PASS	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	FAIL
277	RECV	.018	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	NA
278	RECV	.018	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	FAIL	PASS	PASS	PASS	PASS
279	RECV	.010	PASS	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
280	RECV	.003	PASS	FAIL	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	NA
281	RECV	.001	PASS	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL	PASS	PASS	PASS	PASS
282	RECV	.001	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
283	RECV	.001	PASS	PASS	FAIL	PASS	FAIL	PASS	FAIL	FAIL	PASS	PASS	PASS	NA
284	RECV	.001	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	NA
285	RECV	.001	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS
286	RECV	.001	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	NA
287	RECV	.001	PASS	PASS	FAIL	FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS
288	RECV	.001	PASS	PASS	PASS	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	NA
288	TST2	.001	PASS	PASS	PASS	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	PASS	NA
289	RECV	.021	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS

Legend:

PBF	Lead content of as-received fuel (gm/gal)
PB	Results of Plumbtesmo test
INDT	Induction system (heated air door & temperature sensors)
FUEL	Fuel subsystem (carburetor, idle mixture, idle speed)
CHKE	Choke subsystem (choke adjustment and components, fast idle speed)
IGNT	Ignition system (distributor ass'y, initial timing, spark plugs)
EGR	EGR system (EGR valve ass'y, initial timing, spark plugs)
AIRP	Air injection system (air injection ass'y) valves, drive belt)
PCV	PVC system (PCV value, filter, hoses)
EXHS	Exhaust system (manifold, tailpipe, muffler, catalyst)
EVAP	Evaporative control system (canister, filter, hoses)
MISC	Engine Assembly (engine, cooling system, belt tension)
TWAY	3-way system (electronic control unit, O_2 sensor, other components associated with the 3-way catalyst system)